REVIEWS *(continued)*

Camphor laurel (*Cinnamomum camphora*) – a new weed in north-eastern New South Wales

D. J. Firth
University of New England, Armidale, New South Wales 2350[1]

Summary

Camphor laurel has been widely planted and has become extensively naturalized along coastal eastern Australia. Changes in land use over the last 20 years have led to its development as a weed of fields and roadsides in the Richmond–Tweed region of north-eastern New South Wales. Its distribution, weed status, biology and ecology are described as a basis for the development of effective control strategies for different situations. It is felt that the traditional reliance on mechanical and chemical control could, in many cases, be replaced by longer term environmental management through competition from cultivated forest as well as horticultural and pasture species.

Introduction

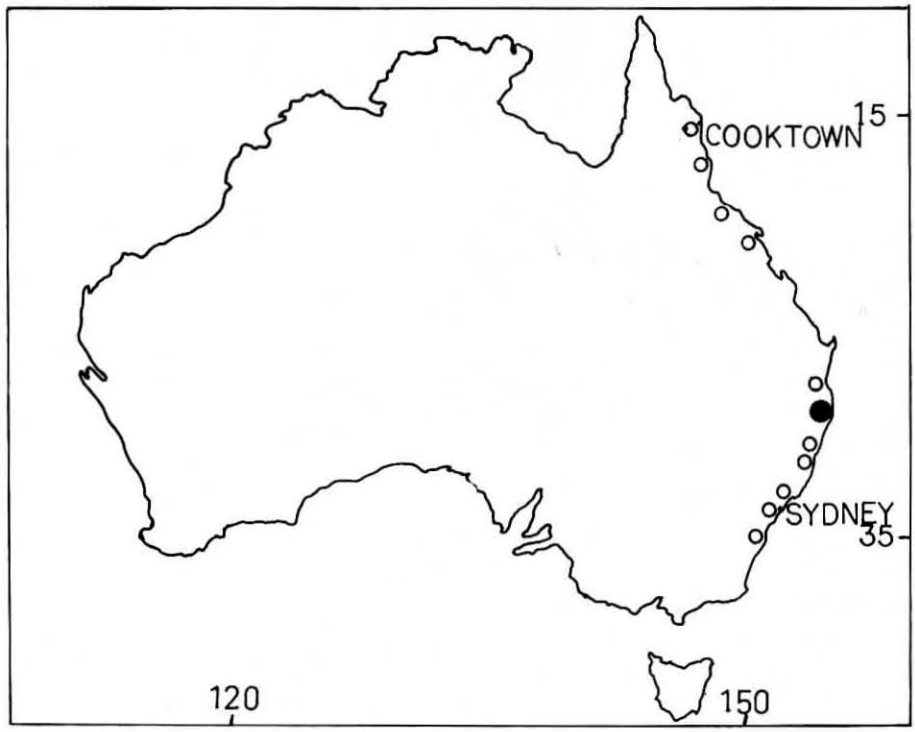
Camphor laurel (*Cinnamomum camphora* (L.) Nees and Eberm) is a stout, evergreen tree up to 30 m high with a trunk 1 to 2 m in diameter. It is commonly naturalized in a strip up to 100 km wide along the east Australian coast where annual rainfall exceeds 1000 mm and frosts are infrequent. It has become an important weed of overgrazed and poorly-managed pastures, abandoned banana plantations and roadways in the Richmond–Tweed region of the far north coast of New South Wales (152°30′–153°40′E, 28°00′–29°15′S). See Figure 1.

The species is a native of southern China and Japan, and has been extensively utilized in that region since the seventeenth century for timber and for the distillation of camphor from its wood. By the end of the nineteenth century it had been introduced to and cultivated in many countries for its chemical constituents, shade, or ornament (Dewey, 1897). It now grows successfully in a wide range of environments throughout the world.

Camphor laurel was introduced into Australia from England as early as 1822 (Firth, in press), and was extensively planted as an ornamental and shade tree in school-grounds, villages and towns along the east coast in 1900–20. It was also planted in shelterbelts on the far north coast of New South Wales at this time (Gorman, 1905; Alexander, 1909). Naturalized trees have established in near proximity to these old source trees, mainly through bird dissemination. The species has only been recognized and studied as a weed in recent years (Firth, 1979).

Distribution

The distribution of camphor laurel in Australia corresponds with the discontinuous occurrence of former rainforest areas along the east coast. A survey was made to determine the range of the species and its general distribution in Australia, and its distribution and abundance according to pre-determined class limits in the Richmond–Tweed region. The Australian survey included ground traverses by motor vehicle as well as information supplied by District Foresters of the New South Wales Forestry Commission and the Queensland Department of Forestry and the Directors of the New South Wales National Herbarium and Queensland Herbarium. The Richmond–Tweed survey involved aerial surveillance and ground traverses by motor vehicle using 1:50 000 topographic maps.



Distribution of naturalized camphor laurel ○

Location of Richmond–Tweed region •

Figure 1 Map showing the generalized distribution of naturalized camphor laurel in Australia and the location of the Richmond–Tweed region on the far north coast of New South Wales

[1] Present address: Agricultural Research Centre, Wollongbar, New South Wales 2480.

The range limits extend from a southern limit (151°E, 35°S) near Nowra in southern New South Wales to a northern limit (145°E, 15°S) near Cooktown in northern Queensland. The species generally occurs at low abundance levels covering less than 1% in a given square kilometre area, except in the Orara Valley and Richmond–Tweed region of north-eastern New South Wales where abundance levels of 20% cover per square kilometre occur in favourable areas. In the latter area camphor laurel is mostly confined to a 20 to 30 km wide coastal strip of elevated red kraznozem soil (Nicholls, Colwell and Tucker, 1953) where annual rainfall exceeds 1400 mm.

A complex of related variables determine distribution and abundance in the Richmond–Tweed region, including rainfall, topography, soil type, settlement pattern, past and present land utilization, the density of source trees and the present vegetation. In low rainfall areas (less than 1400 mm p.a.) colonization is poor regardless of other variables. In high rainfall areas, soil type and elevation are major determinants of distribution; low abundance levels occur on soils other than red kraznozems (partly due to competition from wet sclerophyll forest) and on lowlands subject to waterlogging and frost. In areas of red kraznozem soils with high rainfall, the settlement pattern determines the availability of old camphor laurel trees as seed parents for spreading the species whilst the history of land use controls the availability of suitable habitats. Abandoned cultivation, such as hillside banana plantations, are especially suitable habitats (Figure 2). No particular aspect preference is evident.

Figure 2 Typical cover of camphor laurel in areas formerly occupied by banana plantations in the Richmond–Tweed region

Figure 3 Early establishment of camphor laurel showing lantana as a common associate species

Weed status

Camphor laurel has the common weedy characteristics of excellent adaptation to disturbed environments, abundant seed production with effective dispersal, seed dormancy, hardiness, competitive ability, evidence of allelopathy (Firth, 1979), and ability to reproduce vegetatively. It has not been previously recorded as a weed in the world literature. The species has increased to weed status over significant areas only in the past 10 to 20 years due to abandonment of banana plantations, change from intensive dairying to beef cattle grazing, increase in absentee ownership of land, and decrease in direct control measures.

The increasing area of land being occupied by the species is of concern to landholders in the Richmond–Tweed region. It is part of the successional sequence involving the important herbaceous and shrubby weeds crofton weed and mistflower (*Eupatorium adenophorum* and *E. riparium*) and lantana (*Lantana camara*), but its greater height and coverage, long life cycle, and ability to form single-dominant stands which obstruct productive land use and delay or preclude native rainforest regeneration, give it special status to both farmers and conservationists. Its increasing abundance on roadsides also causes concern to roadside maintenance authorities.

The possibility of conflict between the weed status of camphor laurel and its usefulness is remote. Its only value in Australia is as a shade and ornamental species, and both of these functions can be fulfilled by other species in areas where it could become naturalized. In its native

habitat camphor laurel is still valuable for its timber (Hachiya, pers. comm.), but it has not been used for the production of camphor since the 1920s when that substance was synthesized artificially. In its commercial functions camphor is now partly replaced by eucalyptus oils (Fuchs, pers. comm.).

Biology and ecology

The phenology, seed ecology, seedling development and details of succession of camphor laurel are described elsewhere (Firth, 1980). The species occurs in a number of forms and varieties, classified according to their major oil constitutents (Guenther, 1950). The camphor oil form is the most common in Australia although a cineole form is also found in the Richmond–Tweed region.

The annual growth cycle begins in late winter to spring (August–September) with the opening of mixed buds containing new leaves and inflorescences. The flowers are pollinated by small dipteran flies, and the fruits ripen in April–May. The ripe fruits each contain a single seed and remain attached to the tree. A yield of 113 000 fruits was recorded on a well-laden 15 to 20 year old tree in the Richmond–Tweed area. The seeds are mostly disseminated by birds in their excreta, and may also be transported over considerable distances by water.

Germination is difficult to induce in the laboratory. Mature seeds have considerable dormancy and germinate at a variable rate over 4 to 20 weeks. Ingestion by birds enhances germination, probably by removal of the ripe outer pericarp containing inhibitory substances (Firth, 1979); in the laboratory, immersion of seeds also increases the rate of germination. Seeds lose viability rapidly after two years storage in the laboratory, and no germination occurs after three years.

The growth rate of seedlings is slow. In glasshouse conditions, three fully-formed leaves are present after 3 to 4 weeks on a shoot 3 to 4 cm long, whilst after 6 months the shoot is still only 18 to 20 cm long with eight to ten fully-formed leaves. No advantage is offered by red kraznozem soil in pots in the seedling-establishment stage up to an age of 12 months, indicating that factors other than fertility are responsible for success of the species in the field.

Successional studies indicate a common association with lantana from early establishment (Figure 3) until the closed canopy stage. Less common association species include *Acacia melanoxylon* and the rainforest species *Mallotus philippensis*, *Pittosporum undulatum* and *Guioa semiglauca*, especially in the oldest succession stage. Older stands of 60 to 80 years old are relatively restricted in area, most of the population in the Richmond–Tweed region being less than 20 years old.

Control

For many years control of the species has relied on intensive grazing of pastures and management of banana plantations with hand removal of seedlings. Lopping of field and roadside trees has been carried out in the past, but it is relatively ineffective due to the rapid regeneration from cut stumps.

Chemical control has been practised with some success. Young plants can be killed by an overall spraying of an 0.3% solution of mixed esters of 2,4-D and 2,4,5-T in water or 1% solution if using a misting machine (Anon., 1972). Larger plants can be killed by a basal bark application or cut stump application of a 3 to 5% solution of the same herbicides in oil. Basal bark applications are made in a band 15 to 45 cm wide (depending on the size of the tree) and as close to the ground as possible.

The species was contained in these ways until the 1960s, when the accelerated change from dairying to beef-raising in the Richmond–Tweed region reduced the labour commitment to weed control. The area of abandoned banana plantations has also increased greatly since that time, and such areas have usually been left to revert to weedy regrowth. Roadside infestations of camphor laurel have also increased, due to reduced control measures and to the increasing numbers of seeds from the growing field population.

The merits of mechanical and chemical control of weeds in extensively-utilized rural land, wasteland, and roadside verges is open to argument. Moore proposed in 1975 that control of established noxious weeds in areas greater than 40 to 50 ha is ecologically unsound, in that it merely perpetuates the problem by maintaining the conditions required for their germination and establishment. He suggested that once a weed is naturalized it is difficult to prevent its spread to suitable habitats, and that control measures may be more usefully directed at the site rather than at the plant.

The alternatives for future control of extensive stands of camphor laurel include chemical, biological and ecological methods. Eradication of the species is not practicable because of the extensive area it now covers, and the control of large areas of existing trees by chemical or mechanical means is generally uneconomic and will be ineffective over the long term unless they are replaced by competitive species which are managed to prevent their re-establishment. The introduction of competitive and economically-useful forestry and horticultural species, which may also restore depleted fertility in surface layers of red kraznozem soil, has particular merit in suitable places. Areas presently under intensive pastures will presumably retain conventional control measures of pasture competition and physical and chemical control of seedlings and individual trees. The introduction of biological control agents requires an intensive research effort and would be unacceptable in areas where camphor laurel has shade and ornamental value and is not weedy.

Having consideration for the single-dominance, persistence, and longevity of the species, and its dimensions as a tree-weed, selective chemical control may be more appropriate on roadsides than attempting to modify this habitat by natural succession as proposed by Moore for herb and shrub weeds. This would allow the growth of native rainforest species already present and modify the habitat ultimately to exclude camphor laurel. Removal from roadsides would also eliminate its dispersal to adjacent fields.

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